DOCUMENT RESUME

ED 291 524 PS 017 211

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TITLE Young Children's Reasoning in Games of Nonsocial and Social Logic: "Tic Tac Toe" and a "Guessing Game".
PUB DATE 87
NOTE 24p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Abstract Reasoning; *Childrens Games; *Mathematical Logic; *Young Children
IDENTIFIERS *Social Reasoning

ABSTRACT

This research study tests Selman's (1980) hypothesis that different games pull players toward particular kinds of reasoning through a developmental comparison of children's reasoning in two games, Tic Tac Toe and the Guessing Game. The present study focuses on two basic questions and their educational implications: (1) What differences and similarities in the mastery of game format, in competitive awareness, and in advanced strategies are evident in the playing of these two games? and (2) Do these accomplishments in reasoning appear simultaneously or at different ages? The sample consisted of 87 children aged 3 through 7. Each child played a series of games with the experimenter. It was found that progress in children's reasoning was related to the two games, and that the progress could be described as mastery of mechanics, competitive attitude, and advanced strategy. Differences in children's reasoning were also evident. Progress in reasoning was slanted toward nonsocial logic in tic tac toe, and toward social logic in the guessing game. In addition, there were differences in the ages at which a competitive attitude and advanced strategies emerged in playing the games. A 21-item reference list and five tables are included. (PCB)

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ED291524

Young Children's Reasoning in Games of Nonsocial and Social Logic: "Tic Tac Toe" and a "Guessing Game"

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PS 01211

RUNNING HEAD: Reasoning in Games

The authors would like to thank the participating children, teachers, and administrators in the River Oaks Baptist Church School, the Pearl School, the University of Houston Child Care Center and the University of Houston Human Development Laboratory School for their cooperation. We also thank Wendy Robeson, Inge Oudkerk-Poole, Cheryl Payne-Kelly, and Cory Graber for their assistance in data collection, videotape transciption, and data coding. This research was supported by grants to the first author from the University of Houston Research Initiation Grant program and the University of Houston College of Education Faculty Research Opportunities Program.

Young Children's Reasoning in Games of Nonsocial and Social Logic: "Tic Tac Toe" and a "Guessing Game"

"Games with rules" are both a common childhood occupation and a potential classroom activity. They are an important resource within a childhood "peer culture" (Corsaro, 1985), communicated and passed generationally from children to children largely outside the purview of adults (Opie & Opie, 1975). The value of games, however, has not escaped the notice of theorists. For example, Piaget (1932) documented how children's consciousness and practice of rules developed in the game of marbles. Others have hypothesized that game-playing may contribute to children's knowledge of self (Mead, 1934), to their interactional competence among peers (Denzin, 1975), and to their enculturation to societal values and child-rearing practices (Roberts & Sutton-Smith, 1962).

Across early educational practice, however, the use of games in classroom curricula might be described as "uneven." In line with Piaget's suggestion that natural childhood games nurture intellectual and sociomoral growth (Piaget, 1932; 1945), constructivist educators have emphasized group games as an important component in curricula at the preschool and early primary levels (DeVries & Kohlberg, 1987; Kamii & DeVries, 1980; Kamii, 1985). In contrast, other educators use games more narrowly, to serve a carrier function for traditional academic content (e.g., Blackburn and Powell, 1976; Dunn & Dunn, 1972) or to promote only

physical development. In some classroom modifications, important elements of natural childhood games (e.g., players' control over rules and parameters) are short-circuited to emphasize the learning of content and its evaluation by teachers. In the extreme, these modifications even may turn a playful activity into an aversive one for certain children (Peterson & Fennema, 1983). Finally, some educators regard games as time off-task or as mere "child's play," to be used only as reward or relaxation when classwork is done (Fernie, in press).

Games-with-rules, then, are accorded importance in child-related theories but have no consistent role in educational practice. To bridge this gap between theory and practice, research which documents the relationship between game-playing and specific aspects of development is needed. As DeVries and Smith (1982) have argued, empirical descriptions of reasoning levels about classroom activities can help educators to understand and to assess children's cognitive progress in the very activities which presumably facilitate that development. Following in that vein, the present research examines and compares the reasoning children ages three through seven evidence as they play two typical childhood games.

The design of the current research also draws from Selman's (1980) conceptualization of the relationship between children's reasoning in game-play and the task demands of games. His general hypothesis is that games "load" differently on various task demands which, in turn, exert a pull on players toward particular kinds of reasoning. Of particular relevance here is his distinction between games eliciting nonsocial (mathematical) logic and social logic.

According to Selman, some games load most heavily on the dimension of nonsocial (or mathematical) logic, which pulls a player toward thinking about the probabilities of success for various moves. In Tic Tac Toe, for example, placing an X to complete a winning line of three X's is always a best strategy when it is an available alternative. Other games load most heavily on social logic, which pulls a player toward thinking about the opponent's psychological approach as they try to outwit each other. For example, the Guessing Game (DeVries, 1970; Gratch, 1964) consists of a series of rounds in which one player hides a penny in a fist behind his back, then presents the fists for the other player to guess which hand the penny is in. Here a probabilistic decision among alternatives is not helpful in determining the best moves, but to think about the opponent's thinking (and recursively, about his or her thinking about your thinking) is a useful strategy.

The present study tests Selman's hypothesis through a developmental comparison of children's reasoning in games which load heavily on nonsocial logic (Tic Tac Toe) versus social logic (the Guessing Game). The study focuses on two basic questions and their educational implications: "What differences and similarities in the mastery of game format, in competitive awareness, and in advanced strategies are evident across these two games?" and "Do these accomplishments in reasoning appear simultaneously or at different ages across the two games?"

Methods

Subjects

The sample consisted of 87 children (49 girls, 38 boys) ages three through seven. Subjects were drawn from two preschools and two elementary schools serving families of diverse ethnicity and social class in the same urban area. By age, there were ten 3-year-olds (included to assess "floors" in reasoning in both games), twenty 4-year-olds, nineteen 5-year-olds, eighteen 6-year-olds, and twenty 7-year-olds.[1]

Procedures

The experimenter (E) played a series of Tic Tac Toe games (TTT) and a series of Guessing Games (GG) on consecutive days with one child (C) at a time. Prior to each series, E elicited C's explanation of "how do you play TTT or (GG)?" Review or clarification of the basic game format was provided by E in the few cases where needed. (Generally, children were familiar with both games, though the label "Guessing Game" was not known to all Ss). Following each series, two types of questions were asked in an exploratory interview: A set of questions that fit both games (e.g., "when you play TTT/GG, what do you try to do?", "Did you ever try to trick me?"); and a set of questions specific to TTT or GG (e.g., "if one player puts an X here, what is the best move for the other player?", "when you hid the penny, did you want me to find it?").

Sessions of game play plus interview usually lasted from 20 to 35 minutes. Children were told that they were free to return to the classroom at any time. Each session was videotaped for transcription and

analysis. In addition an observer made a diagram of the order and location of moves in TTT, and recorded the order of choosing left and right fists during GG.

For the GG series, the procedures in Gratch (1964) and DeVries (1970) were used. The C was told simply to "guess which hand the penny is in" as the E repeatedly hid his hands behind his back then presented closed fists. The procedure ensured C's success on 10 trials (E had a penny in each fist) and failure on 10 trials (E had no penny in either fist). Following the 20 opportunities to guess, the C was asked to hide one penny for 10 trials.

For the TTT series, the players placed plastic X's and O's on a light cardboard grid. They alternated which player made the first move in sets of three games. In parallel to the GG progression, E ensured C's early success, this time by allowing C to win the first 6 games. Similarly, a more challenging period followed, this time as the E tried to win the next 9 games. In the 16th and final game, E allowed C to win again.

Analysis

Using both game play and interview data, assessment of TTT reasoning was made by scoring subjects pass-fail on the following items: (1) Imitates game form; (2) takes turns regularly; (3) has a competitive attitude; (4) blocks opponent at least three times; (5) blocks at least 2/3 of times when necessary (i.e., when opponent can win on next play); (6) recognizes that the first line (of three-in-a-row) wins; (7) creates at least three 2-way setups (in which one can win in either of two directions on the next move); (8) shifts appropriately between use of

2-way setups and blocking when necessary (DeVries & Fernie, submitted). These 8 items were found to form a Guttman-type scale, which describes a developmental sequence, using Green's (1956) summary statistics (Reproducibility = .98; Chance Reproducibility = .92; Index of Consistency = .73).

For GG, subjects were scored pass-fail on the following ten items: (1) Attempts to play when asked to hide; (2) does not always hide in same hand; (3) changes penny hand more than once during hiding; (4) hides correctly on at least one trial, that is, imitates the mechanics of the procedure; (5) does not always guess the same hand; (6) changes hand guessed more than once during guessing; (7) almost always hides correctly; (8) has a competitive attitude in hiding, for example, indicates chagrin or disappointment when E guesses correctly, indicates pleasure when E is wrong, tells E to pick hand without penny or extends that hand suggestively; (9) uses shifting strategy in hiding; (10) uses shifting strategy in guessing. These 10 items compose a Guttman-type developmental scale as previously established in DeVries (1970). Scalability was reconfirmed in the present sample (Reproducibility = .98; Chance Reproducibility = .88; Index of Consistency = .79), and mean scale scores for children ages five, six, and seven correspond very closely to those reported in DeVries (1970).

The results which follow only concern comparisons in Ss' play and reasoning across the two games, including correlational and chi-square analyses. For separate elaborations of children's TTT play see DeVries & Fernie (1987) or Fernie & DeVries (1984); for GG, see DeVries (1970).

Results

Reasoning Progress

As reflected by the developmental scales, children's progress in reasoning is positively related in the two games. For both games, mean scale score increases with age (see Table 1) and children's performance across games is positively correlated (r = .73 for 56

Insert Table 1 about here

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perfect scale type Ss, r = .78 for all Ss scorable on both scales). Table 2 shows the cross-tabulated frequency distribution of perfect scale scores in the two games and Table 3 shows the distribution of all scale scores.[2] The steady increase with age in mean scale scores in both games reflects a related progress through age seven in children's reasoning strategies, though the items are different (with one exception) because they are game-specific advances in reasoning.

A wide range of performance within an age group also characterized both games. Typically, same-aged children reasoned at three or four different levels in each game, as indicated by the percentage of subjects passing each scale item (see Tables 4 and 5).

Insert Tables 4 and 5 about here

Competitive Attitude

The one item common to both scales ("has a competitive attitude..."), emerges earlier in TTT than in GG. The majority of 4-year-olds Ss were judged competitive in TTT (60%) but only a small minority (15%) were

judged competitive in GG. Of the 56 subjects who were perfect-scale types, eleven passed "has competitive attitude" in TTT and failed that item in GG, while only one subject had the reverse pattern ($x^2 = 14.45$, $p<.001$).

Advanced Strategies

In contrast to a competitive attitude, advanced strategies occur later in TTT than in GG. For example, only 7 of 87 scorable Ss passed either TTT item related to the advanced strategy of 2-way win setups (items 7 and 8), while 35 Ss used GG's advanced shifting strategy (items 9 and 10), either in hiding the penny or in guessing its location (see Table 3). In a related fashion, the ceiling in TTT reasoning is reached later than in the GG. For GG, almost half (47%) of the 5 year-olds and the majority of 7 year-olds (80%) pass the highest item ("uses shifting strategy in guessing"). In contrast, no 5 year-olds and a very few 7 year-olds (10%) passed the highest TTT item ("shifts appropriately between use of 2-way setups and blocking when necessary). In fact, only a minority of the 8 and 9 year-olds (29%) added to the sample to assess the ceiling in TTT passed this item. Thus, the achievement of the ceiling in TTT reasoning lags behind the achievement of a ceiling in GG reasoning by at least two years in this sample.

In sum, the results suggest the following: first, though developmental progress in reasoning is largely specific to each game, it also is positively related across both games; second, in comparison to GG, TTT is a game in which a competitive attitude is evident at an earlier age, but one in which the advanced strategies appear relatively later.

Discussion

Progress in children's reasoning is positively related across the two games. Conceptually, this progress can be described as a three-level sequence of similar cognitive components evident in each game: mastery of mechanics, competitive attitude, and advanced strategy.

At the first level, children are involved in mastery of the basic mechanics and physical aspects of each game. (TTT items 1-2 and GG items 1-7). In the Guessing Game, for example, young guessers learn to choose different hands and learn to hide the penny effectively prior to the emergence of a competitive attitude. Prior to a competitive attitude in Tic Tac Toe, children learn to place X's and O's within the squares on the grid, to make straight lines as the goal of the game, and to take turns regularly. As these procedural aspects are mastered, game-play appears more socialized and less idiosyncratic.

At the second level, a competitive attitude changes the face of both games (TTT item 3 and GG item 8). The goals of players become both commonly held and oppositional. Children's expressions and comments reveal chagrin when they lose and glee when they win. The "best thing to do", according to many children, is "to win." Moreover, their desire to win motivates them to find more effective strategies when they lose. Thus, a competitive attitude seems to be the fuel which propels the drive toward the more sophisticated play of the third level, advanced strategy.

As this third level (TTT items 5-8 and GG items 9-10), players integrate potent strategies in a manner which respects the reciprocal efforts and abilities of opponents and the contingent nature of good play. In TTT for example, good players learn when to pursue sophisticated

2-way win setups and when to block opponents imminent threats instead. In the Guessing Game, a shifting strategy in guessing acknowledges that one's opponent also may know how to be "shifty."

In contrast to these general similarities, the individual scale items are largely different for the two games. These cognitive components, specific to the possibilities in each game, are consistent with Selman's contention that some games pull thought toward nonsocial (or mathematical) logic while others pull thought toward social logic. One nine year-old articulated how a planned 2-way setup in Tic Tac Toe made winning a mathematical surety after one game: "I would have won both ways...I had it figured out at the beginning that I was gonna do that." And in the Guessing Game, advanced children effectively hide the penny completely and offer both fists exactly the same way, aware of the need to disguise clues and to present an uncertain, literally evenhanded situation to an opponent. The most sophisticated play, shifting strategies in hiding and in guessing, also reflects a recursive social logic of two minds trying to outwit each other (I think that she thinks that I think the penny is here, so....).

The earlier competitive attitude in Tic Tac Toe also may be due to several format differences, differences which may provoke competition in Tic Tac Toe and mask or minimize it in the Guessing Game. Pre-competitive Tic Tac Toe players allow the peaceful coexistence of opponents' "winning" lines with their "winning" lines in different locations on the grid. When played in this way, the games has little suspense or intensity, and seems a desultory ritual to the observer. To add the element of competition adds the challenge and uncertainty of "Who will win?" In contrast, the

Guessing Game contains the suspenseful "hide and uncover" ritual whether players are competitive adversaries attempting to fool each other or noncompetitive associates trying to help each other to find the penny.

Temporal differences in format also may have influenced evidence of competition. Tic Tac Toe contains a series of moves and then a resolution. This invites comment ("What happened?" "Who won?") and provides time for reflection and conversation as the board is cleared. In contrast, the Guessing Game is really a series of continuous rounds, with less clear boundaries for individual games and with fewer opportunities to reflect and talk about previous rounds. In this sample, several children spontaneously spoke of their victory record over the experimenter in Tic Tac Toe (e.g., "I've won five times but you've won only once"), but no one did so during Guessing Game play.

Finally, it is quite plausible that children's competitive attitude in the Guessing Game was present but less apparent to the observer because children masked it in the service of intelligent play. A poker face, to borrow an image from another game involving deception, may constitute an important strategic advantage to develop in games of social logic.

The later appearance of advanced strategies in Tic Tac Toe suggests that the Guessing Game may be the easier of the two games. In order to pass the highest item in the Guessing Game (shifting strategy in guessing), a child indeed must decenter in a recursive fashion. According to DeVries (1970), the child learns "to take account of the-other's-taking-account of the child's perspective" (p. 759). That sophisticated reasoning, however, then translates into the relatively simple action of pointing to one of the opponent's hands.

In contrast, the most advanced Tic Tac Toe strategy requires quite complex reasoning. The child must decenter to conceive of winning lines in two directions simultaneously. At the same time, she must also take the perspective of her opponent to best evaluate imminent threats and the need to block them. To this load is added the weight of greater "rules, limits, parameters, board positions" (Selman, 1980, p. 54); the multiple ways to arrange a 2-way setup on the space grid, the temporal order of play, and the changing options for play as the game's moves and countermoves unfold. Given this configuration of task demands, it is not surprising that the achievement of a ceiling in Tic Tac Toe reasoning is more difficult for children than the achievement of a ceiling in Guessing Game reasoning.

Summary and Educational Implications

This developmental study compared young children's reasoning in two games with hypothetically contrastive task demands. Findings suggest both similarities and differences in reasoning which can provide guidance to early educators interested in games as a classroom activity.

To begin; the similarities. First, progress in reasoning was found to be positively related and to continue through age seven in both games. Second, findings suggested a three-level sequence of cognitive components to describe similar progress in each game, from mastery of mechanics, to a competitive attitude, to advanced strategy. Third, a wide range of reasoning performance within an age group was typical in each game.

These similarities provide useful information for teachers. The related progress in reasoning suggests that young children over a broad age range may continue to be challenged by these two games. The common three level cognitive components, if confirmed in further research, documents a broad developmental progression in children's game-playing abilities and agendas. It may help teachers to understand how younger and older children will approach games (e.g., with an interest in procedural/physical mastery or in competitive play), and to anticipate the broad directions which children's progress in game-related reasoning will take with age and experience. The wide range of performance in reasoning implies that teachers should expect and be sensitive to such variations among same-aged children.

Differences in children's reasoning across games were equally evident in this study's findings, and hold complementary implications for early educational practice. First, as Selman hypothesized, progress in reasoning was slanted toward nonsocial (mathematical) logic in Tic Tac Toe and toward social logic in the Guessing Game. His framework then, has proven helpful in specifying the kinds of reasoning which different types of games elicit. Teachers interested in promoting children's thinking broadly should include games of both types, and/or those which load heavily on both nonsocial and social logic (e.g., certain card games such as Poker).

Second, this research found differences in the ages at which a competitive attitude and advanced strategies emerged in the two games. This suggests that progress in game-related reasoning is not a

straightforward matter of cognitive sophistication, but rather an interaction between children's emergent abilities and particular game's inherent possibilities. Thus, Tic Tac Toe elicited early competition while Guessing Game may have masked it. Perhaps a prudent selection of games for four to six year olds (who varied in whether they had competitive attitudes in these games) should include both "competitive" games and those with intriguing physical procedures and interactional rituals even when played noncompetitively. In selecting games for primary grade children, teachers also should be aware that some games will pose a continuing challenge toward the development of more advanced strategies in reasoning, while others may be virtually mastered by the early elementary years.

In conclusion, this comparison of children's reasoning in Tic Tac Toe and the Guessing Game generally support the Piagetian perspective that games with rules promote intellectual and sociomoral growth. In part, analyses here suggest some common features of this growth in both games. At the same time, the empirical confirmation of Selman's hypothesis specifies how the weight of nonsocial versus social logic task demands may slant the direction of that growth and the ages at which various advances occur. Finally, this comparison provides two descriptions of children's progress in reasoning in childhood games, perhaps serving as examples to help educators better assess and understand the nature, complexities and value of children's games as vehicles to promote children's reasoning.

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Footnotes

1. For TTT, no ceiling was evident by age seven. Consequently, six 8-year-olds and eight 9-year-olds were added to the TTT sample to document the further course of reasoning in this game. Statistical comparisons between TTT and GG play for this report are based only on data from 3 year-olds through 7 year-olds.

2. Perfect Scale-Type Ss are those with no inversion (- +) patterns in scoring, i.e., failure on an item lower in the developmental hierarchy and pass on a higher item. Scale scores represent the total number of scale items passed by the subject regardless of pattern. Consequently, only some Ss are perfect scale type Ss, but a scale score could be assigned to all Ss.

Table 1

Mean Guessing Game and Tic Tac Toe Scale Scores for All Subjects by Age (N=87)

	Scale Score	
Age	Guessing Game	Tic Tac Toe
3	4.40	2.1
4	6.60	2.6
5	8.36	4.26
6	8.67	4.89
7	9.50	5.90

Note: Guessing Game is a 10 item scale and Tic Tac Toe is an 8 item scale

Table 2

Frequency Distribution of Guessing Game Scale Scores and Tic Tac Toe Scale Scores for Pure Scale-Type Subjects (N=56)

	Guessing Game Scale Scores										
Tic Tac Toe Scale Scores	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	1	1	1	1	0	0	0	0
2	0	0	0	0	0	0	3	0	1	0	0
3	0	0	0	0	0	1	2	2	2	1	1
4	0	0	0	0	1	0	3	2	1	4	3
5	0	0	0	0	0	0	0	0	0	3	7
6	0	0	0	0	0	0	0	0	1	3	5
7	0	0	0	0	0	0	0	0	0	1	2
8	0	0	0	0	0	0	0	0	0	0	1

Table 3

Frequency Distribution of Guessing Game Scale Scores and Tic Tac Toe Scale Scores for All Subjects (N=87)

	Guessing Game Scale Scores										
Tic Tac Toe Scale Scores	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	2	1	2	1	0	0	0	0
2	0	0	0	1	1	0	6	1	1	0	0
3	0	0	0	0	0	1	3	3	5	1	1
4	0	0	0	0	1	0	3	2	8	4	3
5	0	0	0	0	0	0	0	2	1	3	6
6	0	0	0	0	0	0	0	0	3	5	9
7	0	0	0	0	0	1	1	1	0	1	1
8	0	0	0	0	0	0	0	0	0	1	1

Table 4

Percentage of All Subjects Succeeding on Each Guessing Game Scale Item

		Item Number									
Age	n	1	2	3	4	5	6	7	8	9	10
3	10	80	80	60	50	50	40	10	10	0	20
4	20	100	100	95	100	95	90	45	15	30	5
5	19	100	100	95	100	100	89	74	68	58	47
6	18	100	100	100	100	100	100	83	78	78	28
7	20	100	100	100	100	100	100	90	100	85	80

Table 5

Percentage of All Subjects Succeeding on Each Tic Tac Toe Scale Item (N=87)

		Item Number							
Age	n	1	2	3	4	5	6	7	8
3	10	100	40	30	30	10	0	0	0
4	20	100	65	60	25	0	5	15	0
5	19	100	100	100	84	32	0	11	0
6	18	100	100	100	94	56	39	0	0
7	20	100	100	95	95	80	70	40	10